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OCT 0 7 2001
L-2001-191
10 CFR § 50.73

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D. C. 20555

Re: Turkey Point Unit 3
Docket No. 50-250
Reportable Event: 2001-003-00
Date of Event: August 15, 2001
Manual Reactor Trip Due to Low Condenser Vacuum

The attached Licensee Event Report 250/2001-003-00 is being submitted pursuant to the requirements of 10 CFR § 50.73 to provide notification of the subject event.

If there are any questions, please call Steve Franzone at (305) 246-6228.

Very truly yours,

John P. McElwain
Vice President
Turkey Point Nuclear Plant

DRL

Attachment

cc: Regional Administrator, USNRC, Region II
Senior Resident Inspector, USNRC, Turkey Point Nuclear Plant

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NRC FORM 366 (1-2001)	U.S. NUCLEAR REGULATORY COMMISSION	APPROVED BY OMB NO. 3150-0104 EXPIRES 6-30-2001
LICENSEE EVENT REPORT (LER) (See reverse for required number of digits/characters for each block)		Estimated burden per response to comply with this mandatory information collection request: 50 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the Records Management Branch (T-6 E6), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to bjs1@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202 (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

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TITLE (4)

Manual Reactor Trip in Response to Low Condenser Vacuum

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MO	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO	MO	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
08	15	2001	2001	- 03 -	00	10	07	01	FACILITY NAME	DOCKET NUMBER

OPERATING MODE (9)	1
POWER LEVEL (10)	16

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply) (11)

	20.2201(b)		20.2203(a)(3)(ii)		50.73(a)(2)(ii)(B)		50.73(a)(2)(ix)(A)
	20.2201(d)		20.2203(a)(4)		50.73(a)(2)(iii)		50.73(a)(2)(x)
	20.2203(a)(1)		50.36(c)(1)(i)(A)	X	50.73(a)(2)(iv)(A)		73.71(a)(4)
	20.2203(a)(2)(i)		50.36(c)(1)(ii)(A)		50.73(a)(2)(v)(A)		73.71(a)(5)
	20.2203(a)(2)(ii)		50.36(c)(2)		50.73(a)(2)(v)(B)		OTHER Specify in Abstract below or in NRC Form 366A
	20.2203(a)(2)(iii)		50.46(a)(3)(ii)		50.73(a)(2)(v)(C)		
	20.2203(a)(2)(iv)		50.73(a)(2)(i)(A)		50.73(a)(2)(v)(D)		
	20.2203(a)(2)(v)		50.73(a)(2)(i)(B)		50.73(a)(2)(vii)		
	20.2203(a)(2)(vi)		50.73(a)(2)(i)(C)		50.73(a)(2)(viii)(A)		
	20.2203(a)(3)(i)		50.73(a)(2)(ii)(A)		50.73(a)(2)(viii)(B)		

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
David Lafleur, Licensing Engineer	(305) 246-7150

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX
B	IL	IG	W120	N	B	AA	ZI	W120	Y
B	IB	PA	W120	N					

SUPPLEMENTAL REPORT EXPECTED (14)				EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
	YES (If yes, complete EXPECTED SUBMISSION DATE).	X	NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16)

On August 15, 2001, at 4:49 AM, with the unit operating at approximately 16% reactor power, a manual reactor trip was initiated in response to low condenser vacuum. Prior to the event, Unit 3 was operating at full power but reduced generation due to a known condenser tube leak in the 3A South Waterbox. Condenser tube leakage resulted in chemistry conditions which forced a unit downpower. At approximately 16% reactor power, a manual reactor trip was initiated in response to indicated low vacuum in the condenser.

The root cause of this event was inadequately designed sensing lines for the control room condenser vacuum instrumentation and the turbine low vacuum alarm. Contributing causes were diaphragm leakage in the turbine trip block and inadequate operating procedures for dealing with high condenser air in-leakage events. Corrective actions include upgrading of sensor lines for condenser vacuum trip and indication instrumentation to eliminate the buildup of condensate and revisions to operating procedural guidance.

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TEXT *(If more space is required, use additional copies of NRC Form 366A)* (17)

EVENT DESCRIPTION

On August 14, at 9:57 PM, Unit 3 was operating at 100% power when it experienced a rapid increase in secondary conductivity. At 9:58 PM, the 3A1 Circulating Water Pump (CWP) [NN:p] was stopped in response to the chemistry excursion. At 10:15 PM, Unit 3 entered Action Level 3 on all Steam Generators (SG) [SB:sg] for sodium, conductivity, and chloride levels and a unit load reduction was commenced due to the deviation from chemistry limits.

On August 15, at 1:40 AM, the unit was at 60% power and continuing to reduce power to Mode 2. The 3AN and 3AS tube bundle suction lines to the condenser Steam Jet Air Ejector (SJAE) [SH:ejr] were isolated by procedure and the 3A2 CWP was stopped at 1:48 AM in order to commence preparations for waterbox inspections and tube repairs. When the 3A2 CWP was shutdown, condenser vacuum began to degrade.

At 3:44 AM, control room operators received a high radiation alarm on SJAE Process Radiation Monitor Alarm System (PRMS) [IL:mon] R-3-15 and responded in accordance with off-normal operating procedures to a possible SG tube leak. At 4:17 AM, Health Physics reported that surveys conducted around the main steam lines, SJAE, and Steam Generator Blowdown (SGBD) [WI] lines indicated no increase in radioactivity. At 4:33 AM, Chemistry reported that there was no gross activity detected in any SG.

At 4:49 AM, at approximately 16% power, the Reactor Control Operator (RCO) performed a manual reactor trip due to a low condenser vacuum reading of 24.2" Hg., as observed on control room indicator PI-3-1406. Operations Department Instruction, ODI-CO-023, states that the reactor shall be tripped if condenser vacuum reaches 24.5" Hg decreasing, when unit Megawatt (MWe) output is less than or equal to 531 Mwe. No annunciator notifying the RCO of low condenser vacuum had been actuated (low vacuum actuation setpoint is 25" Hg.) and no auto low vacuum turbine trip occurred prior to the manual reactor trip. NRC was notified of the trip at 6:30 AM in accordance with 10 CFR 50.72 (b) (2) (iv) (B), actuation of the reactor protection system.

Later analysis of the event revealed the following:

1. The increased loss of vacuum after the isolation of the 3AN and 3AS Waterboxes and the shutdown of the 3A2 CWP was due to the size of the break in the condenser tube coupled with the isolation of SJAE suction lines to the 3A condenser tube bundles and the vent valve to 3AS Waterbox remaining open. All of these actions were performed in accordance with normal operating procedures for shutdown of the waterboxes.

2. Failure of SJAE PRMS R-3-15 was indicative of condensate in the SJAE exhaust line due to the condenser's loss of air removal capability. As air accumulated in the condenser, tube blanketing degraded condenser performance. Greater steam carryover to the remaining SJAE suction lines occurred as condensing action became impaired. Excessive moisture in the SJAE exhaust lines saturated the detector, causing it to read abnormally high.

3. Condenser vacuum degraded substantially beyond the indicated values during the course of the event. Post-trip testing and inspection of the condenser vacuum indicators and the vacuum trip found condensate and oil in the sense lines to the indicators. This condition provided a false, high indication, which was not representative of actual condenser vacuum conditions. The instrumentation failed to reach the low vacuum alarm and automatic turbine trip setpoints. An estimate of actual condenser vacuum based on hotwell temperature during the event indicates that vacuum levels during the event reached much lower levels than

indicated on the instrumentation. Unacceptably low vacuum levels during turbine operation could have caused severe degradation to turbine blading.

All equipment required for mitigation of the event functioned properly with the following exceptions: Intermediate Range Nuclear Instrument N-35 [IG:mon] (IR N-35) tripped on high level and did not clear during the downpower, IR N-36 was spiking high after the trip, and Rod Position Indicator (RPI) [AA:zi] E-9 indicated 120 steps out with its rod bottom indicating light on.

BACKGROUND

Turkey Point Unit 3 is equipped with two 50% capacity condensers, which act as a heat sink for the secondary side of the plant. Main turbine exhaust, various secondary system drains, vents, recirculation flows, and steam dumps go to the condenser. The hotwell section of the condenser collects the condensed steam, drains, and various recirculation flows and provides a surge volume for the feed and condensate system. Cooling for the condensers is provided by the Circulating Water System (CWS). The CWS consists of the 3A1, 3A2, 3B1, and 3B2 CWPs, waterboxes, intake and discharge piping and valves, and a canal system for removing heat from the circulating water. Condenser vacuum is obtained and maintained by a hogging air ejector [SH:ejr] and primary and secondary stage air ejectors during start-up and normal plant operations respectively. Water box priming ejectors are provided to ensure the outlet waterboxes are constantly full of water during start-up and normal operations.

Main condenser vacuum is monitored by three pressure instruments. Control room indication of condenser vacuum is provided by PI-3-1406 and PI-3-1612. PS-3-3614 provides low condenser vacuum annunciation in the control room. At 25" Hg. an alarm will actuate in the control room indicating low condenser vacuum, and at 20" Hg. a condenser low vacuum turbine trip alarm will actuate coincident with turbine trip. PI-3-1406 is the main condenser vacuum indicator used by control room operators. The turbine low vacuum trip is actuated by the turbine trip block at 20" Hg. and shares a sensing line with PS-3-3614.

CAUSES OF THE EVENT

Three individual conditions were necessary to initiate degrading condenser vacuum conditions, which ultimately led to the low condenser vacuum trip. The first event was impact damage breaching two condenser tubes located in the 3AS Waterbox, creating high air in-leakage in the condenser. Impact damage was the result of loose, failed flashing in the condenser [SG]. Next, in anticipation of condenser tube leak testing and in response to rapidly increasing secondary conductivity, the 3A1 and 3A2 CWPs and their associated 3AN and 3AS waterboxes were removed from service. Existing procedures required that SJAE connections to the associated condensers be isolated to prevent steam carryover and condensate binding of the air ejector. Isolation of the SJAE connections reduced the air removal capacity of the SJAE. Finally, and also in accordance with procedures, the vent valve to the 3AS Waterbox priming jet remained opened. This provided an open air path to the condenser, increasing air in-leakage rates in parallel with a decrease in air removal capacity.

The root cause of the event was inadequately designed sensing lines for control room condenser vacuum indicator PI-3-1406, pressure switch PS-3-3614, and the turbine trip block. The design of the sensing lines allowed for the buildup of condensate. The creation of a water column in the sensing lines induced a higher

than actual condenser vacuum reading. Since PI-3-1406 is the primary control room indicator for condenser vacuum, RCO responses based on indication led to the subsequent manual trip. Water residue collected from the sensing line would have been sufficient to induce a 3-foot column, which is enough to have created an offset of approximately 3" Hg. on the indicator.

A contributing cause to the event was diaphragm leakage in the turbine trip block into the common sense line shared with condenser pressure switch PS-3-3614. PS-3-3614 provides actuation for two control room annunciators on low condenser vacuum. At 25" Hg., PS-3-3614 is designed to actuate the low condenser vacuum alarm [SH:pa] in the control room. At 20" Hg., PS-3-3614 will actuate the low condenser vacuum turbine trip alarm [SH:pa]. Subsequent inspection of the trip block revealed a slight diaphragm leak, which allowed Turbine Auto Stop Oil to enter the vacuum sensing line. This leakage combined with condensate created a column of oil and water sufficient to create an offset of 3.3" Hg. at the pressure switch. Vacuum based on hotwell temperature recorded during the event indicates that actual vacuum may have been as low as 19" Hg. This offset delayed the responses of the pressure switch and the trip block such that the condenser low vacuum alarms were never actuated to notify operators of degrading condenser vacuum and the turbine low vacuum auto trip was never actuated at its anticipated setpoint of 20" Hg.

Another contributing cause to the event was inadequate operating procedures for dealing with high condenser air in-leakage events. For this specific event, the SG chemistry excursion was an indicator of a substantial condenser tube failure and a potential condenser air ingress pathway. The potential to adversely impact air removal capacity associated with securing CWPs and the associated SJAE lines was not identified in applicable procedures. Initiation of additional air removal capacity using the condenser hogging air ejector is addressed in the condenser low vacuum alarm off-normal operating procedure and is not considered as a preventative action in operating procedures. No procedure itemizes the warning signs or consequences of increasing air blanketing, nor positions operators to recognize and combat those consequences. As a result, licensed operators made a series of decisions that initiated and compounded the degrading condenser vacuum, by using existing procedural guidance. The 3A2 CWP was secured and the 3AN and 3AS SJAE suction lines were isolated, significantly degrading the ability of the condenser to collect and remove noncondensable gases. The vent valve to the 3AS Waterbox was permitted to remain open, providing an unobstructed flow path for air ingress. Condenser vacuum response, which was degrading but above procedural limitations using control room instrumentation, did not prompt consideration of the use of the condenser hogging air ejector. Failure of SJAE PRMS R-15 was not recognized as an indicator of steam binding in the SJAE and loss of air removal capability.

ANALYSIS OF SAFETY SIGNIFICANCE

The condenser continued to function as a heat sink and condenser steam dumps remained operable throughout this event. Thus, no loss of heat sink applies to this reactor trip event.

Severely degraded turbine blading could have lead to turbine damage and blade ejection. Turbine missiles however are not considered a threat to vital systems, structures or components. Hypothetical missiles that could be generated from various components are considered in the design of the plant. Components and systems that are essential for the safety of the public and are required to function immediately after a Maximum Hypothetical Accident, are protected by either concrete barriers designed to resist missile impact or by redundancy and spacing to maintain their integrity with no loss of function.

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The unit was stabilized in Mode 3 in accordance with approved plant procedures. Post-trip review established that plant parameters responded as expected. A reactor trip is a previously analyzed event. Thus, the health and safety of the public were not affected by this event.

CORRECTIVE ACTIONS

1. The following corrective actions were performed prior to unit restart:
   a. Visual inspections were performed on turbine low-pressure blading. One blade was determined to have a fatigue crack in its root. The affected blade and the opposite blade were removed.
   b. A helium leak inspection of the 3AS Waterbox outlet tubesheet was performed. Two condenser tubes were plugged due to leakage and preventative plugging was performed.
   c. Sensing lines to control room condenser vacuum instrumentation and the turbine trip block were cleared.
   d. The turbine trip block diaphragm was replaced.
   e. Turbine low vacuum trip PS-3-3614 was replaced and calibrated.
   f. PI-3-1406 and PI-3-3614 were calibrated.
   g. Training briefs were issued to operators prior to unit restart, addressing cross-checking of condenser vacuum indication and the use of diverse means to verify vacuum levels.
   h. SJAE PRMS R-3-15 was inspected and returned to service.
   i. IR N-35, IR N-36, and RPI E-9 were repaired and returned to service.
2. Unit 3 and 4 condenser flashing and unit 3 low-pressure turbine blading will be inspected for degradation with corrective actions taken as necessary during the next refueling outages.
3. The topmost exposed condenser tube row(s) will be plugged in both units 3 and 4 to eliminate exposure to flashing impact originated tube damage.
4. Sensing lines to the turbine trip block and PS-*-3614 of both units 3 and 4 will be upgraded to eliminate the buildup of condensate.
5. Other vacuum instruments will be evaluated for modifications to improve accuracy, reliability, and redundancy.
6. Operating procedures will be revised to incorporate information relating to power reductions with potentially high air in-leakage rates and use of diverse means to verify vacuum levels.
7. A letter was sent to operations management personnel describing and emphasizing the role and importance of control room management oversight.

ADDITIONAL INFORMATION

EIIS Codes are shown in the format [EIIS SYSTEM: IEEE component function identifier, second component function identifier (if appropriate)]. There have been no previous similar events at Turkey Point Units 3 and 4.